

REMARKS

This Amendment filed in reply to the Non-Final Office Action dated April 26, 2007, is believed to be fully responsive to the objections and rejections raised therein. Accordingly, favorable reconsideration on the merits is respectfully requested.

In the present Amendment, claim 1 has been amended by replacing "9 to 100 carbons" with ---12 to 100 carbons---.

Claims 5 and 11 have been amended to improve their form.

Claims 12 and 20 have been canceled.

Claims 13-19 have been previously withdrawn, and are currently amended. Claims 13-19 have been amended to incorporate the limitations of claim 12 and to change the claim dependency from claim 12 to claim 1.

No new matter has been added. Support for the amendment can be found throughout the Specification, particularly at page 6, lines 1-3; page 9, lines 4-15; and page 11 at lines 13-19. Entry of the Amendment is respectfully requested. Upon entry of the Amendment, claims 1-11 and 13-19 will be all the claims pending in the application.

**I. Response to Restriction**

Applicants acknowledge election of Group I, claims 1-11, directed to products. The claims, as amended, are now believed to be in condition for allowance. Claims 13-19 depend from claim 1 and require all the limitations of claim 1. Thus, Applicants respectfully request rejoinder of claims 13-19 pursuant to M.P.E.P. § 821.04(a).

**II. Response to Claim Rejections Under 35 U.S.C. § 103(a)**

Claims 1, 5 and 7-10 are rejected as being allegedly unpatentable over U.S. 4,359,596 to Howard et al. (hereinafter as "Howard et al."). According to the Examiner, Howard et al. teaches "tri-n-butyl-2-ethylhexylphosphonium chloride which comprises an eight carbon branched alkyl group." (Office Action of 4/26/07 at p. 3, ll. 14-15). The Examiner further alleges that claim 1 is a homolog of Howard et al., which is one methylene group short of meeting the limitations of present claim 1. (See, Office Action of 4/26/07 at p. 3, ll. 19-20). Further, the Examiner states that members of the same homologous series must possess unexpected properties not possessed by the homologous compounds disclosed by the prior art. (Id. at p. 4, ll. 1-3).

Applicants respectfully submit that claim 1, as amended, is distinguishable over Howard et al. Claim 1 has been amended to recite "a tetraalkylphosphonium salt having at least one branched alkyl chain containing 12 to 100 carbon atoms." One of ordinary skill in the art knows that a surfactant forms a micelle when the concentration of the surfactant is higher than a specific concentration (a critical micelle concentration [cmc]). As shown in Table 16.2 of Intermolecular and Surface Forces, 2nd Edition, as attached herewith, surfactants having at least 12 carbons form a micelle, but surfactants having 4 to 8 carbons do not. (See, Intermolecular and Surface Forces, 2<sup>nd</sup> Ed., Table 16.2, attached herewith as an Appendix). The surfactant having at least 12 carbons, as recited in claim 1, is therefore distinguishable over surfactant having at most 8 carbon atoms as described in Howard et al. Applicants respectfully request withdrawal of the rejection in view of the amendment of claim 1.

**III. Response to Claim Objections**

Claims 2-4, 6 and 11 are objected to as being dependent upon a rejected based claim.

Applicants respectfully submit that claim 1 is now in condition for allowance. Withdrawal of the claim objections is respectfully requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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INTERMOLECULAR AND SURFACE FORCES

hydrocarbon (which determines their solubility) or into micelles (which determines their CMC) can be analysed in a similar fashion. Thus, for an alkane chain of radius  $r \approx 0.2$  nm and an interfacial energy with water of  $\gamma \approx 50$  mJ m<sup>-2</sup> as above, the hydrophobic energy per unit length will be  $2\pi r \approx 6 \times 10^{-11}$  J m<sup>-1</sup>. Now, since the CH<sub>2</sub>-CH<sub>2</sub> distance along a chain is  $l = 0.126$  nm, this value corresponds to  $8 \times 10^{-21}$  J per CH<sub>2</sub> group added to the chain. Experimentally, one finds an increment of about  $6.3 \times 10^{-21}$  J (equivalent to 900 cal mol<sup>-1</sup> or 3.8 kJ mol<sup>-1</sup>) per CH<sub>2</sub> group added to a pure alkane chain at 25°C (Tanford, 1980). This corresponds to an increment in  $\alpha$  of  $6.3 \times 10^{-21}/kT \approx 1.5$  and thus to a lowering of the solubility of alkanes in water by  $\alpha^{-1.5} \approx 0.22$ , i.e., by a factor of about four, per added CH<sub>2</sub> group (see first row of Table 16.2).

The above applies only to pure alkane chains being transferred from water into a pure bulk hydrocarbon phase. In the case of surfactant molecules being transferred into micelles or bilayers, the hydrophobic energy increment is significantly lower, ranging from 1.7 to 2.8 kJ mol<sup>-1</sup> per CH<sub>2</sub> group (Table 16.2). As discussed in Section 8.7 the reduced hydrophobicity of an amphiphilic chain compared to that of a pure alkane chain is believed to be due to the proximity of the hydrophilic headgroup, and to the higher chain ordering of chains within micelles which acts to reduce the energy even more (Andersson, 1978). The above range of values means that typical molecular CMCs fall by 0.3 to 0.5 (i.e., by a factor between 2 and 3) per CH<sub>2</sub> group added to the surfactant chain.

The important difference between alkanes and amphiphilic molecules is not so much in their solubility or CMC values but in the ability of amphiphiles to assemble into structures in which  $\rho\phi$  reaches a minimum or constant value at some finite value of  $N$ . It is for this reason that the aggregates formed are not infinite ( $\rightarrow$  phase separation) but of finite size ( $\rightarrow$  micellification). The reasons for why and how amphiphilic molecules do this will be investigated fully in the following chapter.

### 16.7 SIZE DISTRIBUTIONS OF SELF-ASSEMBLED STRUCTURES

Micelles and vesicles in equilibrium with each other in solution usually have a finite distribution of size about some mean value. The distribution may be narrow or broad (polydisperse), and it may be symmetrical or asymmetrical about the mean. Here we shall investigate how polydispersity comes about, starting with a consideration of aggregates for which  $p = 1$  in Eq. (16.11).

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TABLE 16.3 CMCs of some common surfactants and lipids showing the effects of chain length, number of chains,<sup>a</sup> type of headgroup, counterion, color, salt and temperature (see Problem 16.1)

Surfactant ( $R_n = C_nH_{2n+1}$ )	Total number carbon atoms in chains	CMC <sup>b</sup> (mM)	Increment of CMC per CH <sub>2</sub> group (l)	Average energy per CH <sub>2</sub> group ( $\Delta G \approx RT \ln l$ )
Pure n-alkanes (no headgroup)	4-8	(solubility)	4.4	3.7 kJ mol <sup>-1</sup> (880 cal mol <sup>-1</sup> )
<b>Cationic</b>				
Alkyl trimethylammonium bromides				
$R_{10}\text{-N(CH}_3)_3^+ \text{Br}^-$	10	66	2.1	1.8 kJ mol <sup>-1</sup>
$R_{12}\text{-N(CH}_3)_3^+ \text{Br}^-$	12	15	2.1	(430 cal mol <sup>-1</sup> )
$R_{14}\text{-N(CH}_3)_3^+ \text{Br}^-$	14	3.5	2.0	
$R_{16}\text{-N(CH}_3)_3^+ \text{Br}^-$ (CTAB or HTAB)	16	0.9		
Alkyl trimethylammonium chlorides				
$R_{10}\text{-N(CH}_3)_3^+ \text{Cl}^-$	10	63	1.8	1.7 kJ mol <sup>-1</sup>
$R_{12}\text{-N(CH}_3)_3^+ \text{Cl}^-$	12	19	2.1	(400 cal mol <sup>-1</sup> )
$R_{14}\text{-N(CH}_3)_3^+ \text{Cl}^-$	14	4.3	1.8	
$R_{16}\text{-N(CH}_3)_3^+ \text{Cl}^-$	16	1.3	2.0	
$R_{18}\text{-N(CH}_3)_3^+ \text{Cl}^-$	18	0.34		
<b>Anionic</b>				
Sodium alkyl sulphates				
$R_8\text{-SO}_3^- \text{Na}^+$	8	130	2.0	1.7 kJ mol <sup>-1</sup>
$R_{10}\text{-SO}_3^- \text{Na}^+$	10	33.2	2.0	(410 cal mol <sup>-1</sup> )
$R_{12}\text{-SO}_3^- \text{Na}^+$ (SDS)	12	8.1	2.0	
$R_{14}\text{-SO}_3^- \text{Na}^+$	14	2.0		